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FIGS AND THE PERSISTENCE OF TOCO TOUCAN (*RAMPHASTOS TOCO*) AT DRY FORESTS FROM WESTERN BRAZIL

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Resumo. – **Figos e a permanência do Tucano Toco (*Ramphastos toco*), em florestas estacionais do oeste brasileiro. –** O Tucano Toco (*Ramphastos toco*) é um grande frugívoro do dossel comum nas florestas estacionais do interior do Brasil. Nesse estudo avaliei a produção de frutos e analisei os hábitos alimentares dessa espécie em dois tipos de florestas estacionais, uma altamente decídua, embora rica em figueiras, e outra semi-decídua, ambas no oeste brasileiro. Essas florestas exibiram padrões de frutificação fortemente sazonais, cujos picos se deram no período que compreende o final da estação seca e início da chuvosa. No entanto, na floresta altamente decídua a maior parte do pico consistiu de frutos secos, enquanto que na semi-decídua de frutos carnosos. Na floresta altamente decídua, apesar das flutuações, a oferta de figos foi permanente ao longo do ano. Na floresta semi-decídua, a atividade alimentar dos tucanos variou substancialmente apresentando picos coincidentes com o a oferta de frutos estacionais, principalmente os diásporos de *Guibourtia hymenaefolia* e *Schefflera morototoni*. Esses frutos estiveram disponíveis por longos períodos e, potencialmente, eram ricos em lipídeos. Por outro lado, na floresta altamente decídua os Tucanos Toco consumiram figos todos os meses, de tal forma que a atividade alimentar nessa área foi similar em ambas as estações do ano. Portanto, a exploração de habitats distintos como causa da oferta de frutos estacionais ou assincrônicos, enfatiza a importância dos mosaicos de habitat para um grande frugívoro, como o Tucano Toco, que tipicamente explora áreas amplas à procura de espécies frutificando. Os dados apresentados aqui ampliam nossos conhecimentos sobre os hábitos generalistas dessa espécie que, pelo menos em parte, explicam sua persistência e ampla distribuição no interior seco do Brasil.

Abstract. – The Toco Toucan (*Ramphastos toco*) is a large canopy frugivore common in the seasonal areas of the interior of Brazil. In this study, I evaluated fruit production and analyzed the toucan's feeding habits in two types of dry forests, one deciduous, although rich in figs, and another semi-deciduous, both in the western Brazil. Both areas exhibited marked fruiting patterns, which peaks overlapped the late dry and early wet seasons. However, in the deciduous forest the fruiting peak resulted mostly of dry fruits, while in the semi-deciduous forest the major peak was widely comprised by fleshy fruits. On the other hand, in the deciduous forest, despite of fluctuations, figs were available all year. In the semi-deciduous forest, the feeding activity varied substantially exhibiting peaks coincident with the extensive consumption of seasonally available fruits, mainly *Guibourtia hymenaefolia* and *Schefflera morototoni*. These food resources presented such traits as prolonged availability and lipid-rich diaspores. Conversely, in the deciduous forest Toco Toucans foraged every month, mostly for figs, so that their feeding activity exhibited no significant seasonal differences. Therefore, the exploitation of distinct habitat types caused either by asynchronous or seasonal fruits, emphasizes the importance of habitat mosaics for a large frugivorous bird, such as the Toco Toucan, which wanders for wide areas searching for fruiting patches. Data present here increase our knowledge on the species' generalistic habits, which at least partly may explain its persistence and wide distribution in the dry interior of Brazil. *Accepted 16 December 2009.*

Key words: Ramphastidae, *Ramphastos toco*, Toco Toucan, dry forests, feeding ecology, frugivory, western Brazil.

INTRODUCTION

In Neotropical forests, fruit production fluctuates seasonally (or supra-annually), with fruiting peaks alternating with periods of fruit scarcity (Foster 1982, van Schaik *et al.* 1993). Particularly, in dry forests many tree species fruit synchronously enhancing potential peaks (Janzen 1967). Together with the trend for tree species to be clumped in distribution, this often causes high patchiness of fruit resources availability in space and time (Hubbell 1979, van Schaik *et al.* 1993). In fact, fruit availability may influence both habitat quality and landscape movements of frugivorous birds (Levey 1988, Blake & Loiselle 1991, Kinnaird *et al.* 1996, Ragusa-Netto 2006, 2007, 2008a,b). Therefore, at a given area the presence and composition of fruiting plant species directly affects its suitability for frugivorous birds, especially in providing adequate fruit resources (van Schaik *et al.* 1993, Kinnaird *et al.* 1996, Walker 2007, Ragusa-Netto 2008b). The level of dependence on fruits has important consequences for the nutritional status and physiology of frugivores (Fuentes 1994), which in turn can determine their choice of fruits. Certain fruit species are particularly important either because they dominate the diets of bird species (Walker 2007) or act as keystone species. Potentially, figs are the most widespread keystone fruits for tropical birds (Lambert & Marshall 1991, Bleher *et al.* 2003).

Figs are well known by sustaining frugivores through periods of resource scarcity (Lambert & Marshall 1991). Unlike seasonal tree species, *Ficus* species fruit asynchronously, making their fruits available throughout the year (Peres 2000). In many tropical regions, figs are essential for many vertebrates (Foster 1982, Kinnaird *et al.* 1996, Bleher *et al.* 2003), especially during periods of seasonal fleshy fruit decline when the absence of *Ficus* resources could result in the extinction of many arboreal frugivores (Lambert & Marshall 1991). In fact, due to the variable patterns of fig availability frugivorous birds exhibit a sort of life-history and behavioural traits to effectively track fruit resources. Therefore, their foraging decisions may depend on the availability of seasonal and/or asynchronous food resources of a given habitat type (Kinnaird *et al.* 1996, Anggraini *et al.* 2001).

The feeding ecology of large Neotropical frugivorous birds, such as toucans (Ramphastidae), remains poorly known (but see: Skutch 1971, Galletti *et al.* 2000, Ragusa-Netto 2006, 2008b). Among *Ramphastos* species, Toco Toucan is singular by using both continuous and semi-open habitats of the dry interior of Brazil (Sick 1997, Short & Horne 2002). Particularly, in the diverse and seasonal cerrado (Brazilian savanna) the Toco Toucan forages either in dense or savanna-like habitat for lipid- and sugar-rich fruits (Ragusa-Netto 2008b). However, the Toco Toucan is also common in the dry forests of western Brazil in which it often forages in fig-rich areas (Ragusa-Netto 2002). The canopy of Neotropical dry forests exhibit marked seasonal fruiting patterns (Bullock & Solis-Magallanes 1990, Funch *et al.* 2002, McLaren & McDonald 2005, Ragusa-Netto 2008a). In this respect, both strong diet shifts and fluctuations in abundance (van Schaik *et al.* 1993), are expected for frugivorous birds, such as the Toco Toucan (Ragusa-Netto 2008b). In fact, canopy frugivorous birds are likely to be most abundant when and where fruits are most abundant (Kinnaird *et al.* 1996, Renton 2001). Fig-rich forests may be highly important for canopy frugivorous birds of seasonal areas, mostly during the prolonged dry season when fleshy fruit production, potentially, declines abruptly (van Schaik *et al.* 1993). In this respect, the question is raised if Toco Toucan feeding activity might be influenced by the fruiting pattern and the fig abundance in the dry forests? To address this question, I

assessed the use of dry forests for feeding purposes by the Toco Toucan in western Brazil. Particularly, I analysed the exploitation of fruits by toucans both in a fig-rich and -poor dry forests. Also, I analysed the relationship between fruiting pattern and feeding activity of Toco Toucans at both areas.

METHODS

Study areas. This study was carried out at a deciduous forest (57°41'W and 19°01'S, elevation ± 130 m a.s.l.), and at a semi-deciduous forest (in the foothills of the Urucum mountain chain, 57°34'W, 19°16'S, elevation 150–200 m; distance between areas = 30 km), both near the city of Corumbá, Mato Grosso do Sul State. The deciduous forest site is part of a dry forest belt around Corumbá, which occurs on calcareous rich soil both in flat and hilly terrain. Although most of the area is covered by primary forest, there are disturbances caused by logging, resulting in clearings in the flat area. Mean annual temperature is 25°C. Annual rainfall is around 900 mm, with 700 mm falling from November to March (wet season), and 200 mm from April to October (dry season). The vegetation includes deciduous trees with a canopy of 8–13 m. Species such as *Anadenanthera colubrina* (Leguminoseae), *Miracrodruon urundeuva* (Anacardiaceae) *Tabebuia impetiginosa* (Bignoniaceae), *Ceiba pubiflora* (Bombacaceae), *Cereus peruvianus* (Cactaceae), and *Ficus calyptroceras* (Moraceae) were among the commonest species.

In the hilly terrain of Urucum there is a gradient of vegetation types, formed by semi-deciduous forest in the foothill, followed by low dry forest up to the timberline (700–800 m), and rock fields up to the top (approximately 1100 m). In the undulated topography of the foothills, wet valleys are interspersed with dry peaks. The canopy in this tract is 12–15 m tall, but emergent trees may reach 17–18 m. From June to September many tree species drop their leaves (mainly at peaks), while in the wet valleys some abundant species remain evergreen contributing to an evident semi-deciduous pattern. Common tree species were *Protium heptaphyllum* (Burseraceae), *Erioteca roseorum* (Bombacaceae), *Dipteryx alata* (Leguminosae), *Astronium fraxinifolium* (Anacardiaceae), and *Guarea guidonea* (Meliaceae). Annual rainfall is around 1100 mm, most of which (75–85%) occurs from October to March (wet season). During the wet season average temperature is 26°C, while during the dry season (April to September) on average 19°C is recorded, and in the coldest months frosts may occur.

Fruit production. I sampled fruit production using three phenology trails (Chapman *et al.* 1994), each of which were positioned alongside the permanent access trails (6 km at the foothills of each forest type), and each spaced one from the other by 2.0 km, as well as 1.0 km from the forest border. At each phenology trail (length = 300 m), to specifically sample fruit production in the canopy, I selected only the 50 largest canopy or emergent trees (DBH ≥ 30), because smaller trees often might be immature rendering small or even no fruit crop (Chapman *et al.* 1992). I monitored no understory tree because, besides scarce, Toco Toucans tend to ignore fruits in this vegetation layer (Sick 1997, Short & Horne 2002, Ragusa-Netto 2006, 2008b). This sample of 300 trees was unknown with respect to their importance for Toco Toucans. Monthly, from February 2001 to January 2002 I monitored, at each habitat type, individual crowns for the presence of fruits with 8 x 40 binoculars. The abundance of fruits was ranked on a relative scale, ranging from total absence (0) to a plentiful fruit crop (4; Fournier 1974). Thus, for each habitat type, the sum of scores resulted in a monthly index of fruit abundance. Tree species were identified by comparison with samples in the herbarium

at the Universidade Federal do Mato Grosso do Sul (Campus Corumbá); nomenclature followed Lorenzi (1994, 1998). Previous studies indicated substantial differences in fig density (*Ficus calyptroceras*) and respective consumption by frugivores at each forest type (Ragusa-Netto 2002, 2008a). In fact, only two fig trees occurred in the three phenology trails of semi-deciduos against nine in those ones of deciduos forest. Then, due to the fig scarcity in the semi-deciduous forest I sampled fig abundance only in the deciduous one to assess temporal fluctuations in fig production (Ragusa-Netto 2002). In the 6 km long permanent access trail I marked with numbered aluminum tags 50 individuals of *Ficus calyptroceras* (DBH ≥ 30 cm), which were monitored every month (also from February 2001 to January 2002), for fig production. Fig abundance was also visually estimated using 8 x 40 binoculars, and scored on a relative scale from 0 to 4. The sum of scores resulted in a monthly index of fig abundance. The analysis of dispersal syndromes was out of the scope of this study. Hence, the fruits were classed only according to the presence of fleshy edible parts, rather than dispersal features (zoochory, autochory, and anemochory). Thus, tree species whose diaspores included pulp or aril were assigned as species with fleshy fruit, whereas those ones with dry mesocarp were classed as species with dry fruits.

Fig density. To compare fig density (*Ficus calyptroceras*) between both areas I sampled fig abundance using the point center quadrant technique (Krebs 1989). At each area I used the same trails established for the phenology sample, in which I positioned 10 points (each 15 m from the other, total = 30 points/forest type). At each point I sampled the four closest trees with DBH ≥ 20 cm (potentially mature trees). I sampled fig density in January 2002, after sampling tree phenology and Toco Toucan feeding activity (see below).

Toco Toucan food resources use. To sample the exploitation of food resources by Toco Toucan, I used, at each forest type, the trails described above. Every month, I walked these trails for 30 h (15 h per forest type), from 05:00–8:00 h, and from 16:00–18:30 h, in the wet season; from 06:00–09:00 h, and from 15:30–18:00 h (EST), in the dry season. These periods corresponded to toucans peak activity (Marsden 1999). Toucans may spend prolonged periods (up to 10 min, Howe 1981) foraging at a given crown. To avoid resampling toucans feeding on a specific food source during an observation period, I walked the trails only in one direction. Whenever I spotted at least one feeding toucan, I recorded: a) tree species, b) food resources (flower, fruit, or arthropod), c) part eaten (petal, nectar, pulp, or aril), and d) number of toucans eating. If toucans capture arthropods I recorded the size (cm, visually estimated) and taxa (usually order). Then, I recorded only the first ingestion of a specific food item eaten by Toco Toucans. I used the initial instead of sequential observations of feeding toucans to assure the independence among feeding samples, because it can be assumed that the birds are equally likely to be seen feeding on any conspicuous food source (Hejl *et al.* 1990). Also, at both sites I assumed that the conspicuous Toco Toucans were equally likely to be detected at medium short distances (20–50 m; Marsden 1999), because, from the perspective of an observer on the forest floor, both forest types provided a similar field of view due to the scarce understory.

Analyses. In seasonal forests fruiting pattern fluctuates exhibiting short periods of pronounced fruit enhancement followed by abrupt declines (Bullock & Solis-Magallanes 1990, Funch *et al.* 2002, McLaren & McDonald 2005, Justiniano & Fredericksen 2000). Hence, in the course of a season fruit

production tends to exhibit inverse patterns which have implications for frugivores (van Schaik *et al.* 1993). Then, taking into account the potential intra-seasonal changes in fruit production (Renton 2001, Ragusa-Netto 2007, 2008a) at each habitat type, I compared fruit abundance in four periods of the year by Kruskal-Wallis test. The periods were the following: late wet season (January–March), the early dry season (April–June), the late dry season (July–September), and the early wet season (October–December). The monthly index of resource abundance (= sum of scores) were taken as variable for these comparisons. At each habitat type, the total number of Toco Toucans recorded monthly ingesting food resources was taken as an index of feeding activity. To analyze the temporal use of feeding areas, I compared the proportion of individuals recorded feeding at each habitat type in the same four periods of the year using Chi-square test. In this analysis I took as a replicate each observation of a Toco Toucan spotted ingesting a given food item.

RESULTS

Fruit production and fig density. In both forests, the general fruiting patterns were markedly seasonal exhibiting pronounced peaks. Particularly, in the deciduous forest fruit production was higher during the late dry season (August and September, Fig. 1A), while in the semi-deciduous forest a very pronounced fruiting peak occurred in the transition from the dry to the wet season (Fig. 1B). Therefore, fruit abundance differed significantly between the four periods of the year both in the deciduous (Kruskal-Wallis, $H = 8.95$, df = 3, $P = 0.03$) and semi-deciduous ($H = 7.90$, df = 3, $P = 0.04$) forest.

In the deciduous forest much of the fruiting peak resulted from fruit production in species, such as *Anadenanthera colubrina*, *Acacia paniculata*, *Myracrodruon urundeuva*, and *Ceiba pubiflora*, all of which bore dry fruits. With the progress of the wet season, dry fruit production declined to the lowest level in November. At this time, only a few individuals of *Commiphora leptophloeos* bore fleshy fruits. Fruits available for Toco Toucans were mainly *Ficus calyptroceras* (nine trees monitored in the three phenology trails), *Sterculia striata* (two trees), and *Commiphora leptophloeos* (four trees, Fig. 1A).

In the semi-deciduous forest part of the fruiting peak (mainly in August and part of September) arose from fruiting in *Anadenanthera colubrina*, *Erioteca roseorum*, *Astronium fraxinifolium*, and *Dipteryx alata*, all of which, except the last one, bore dry fruits. On the other hand, the bulk of this peak (September to November) resulted from fruiting in species, such as *Protium heptaphyllum*, *Guarea guidonia*, *Pouteria torta*, and *Spondias lutea*, which produced large crops of fleshy fruits. Only two fig trees were monitored in this area, with one fruiting in May and the other in December.

Among fig trees (n = 50) monitored in the deciduous forest, 6 produced no figs, 32 bore figs once, and 10 bore figs twice. The mensal fig production fluctuated abruptly within every season (extremes in August and September 2001, sum of scores = 49 and 10, respectively, Fig. 1C). However, due to this variable fig availability no seasonal fruiting pattern emerged, therefore fig abundance differed not significantly in the four periods of the year (Kruskal-Wallis, $H = 2.17$, df = 3, $P = 0.54$, Fig. 1C). Fig density was highly different between areas. In the deciduous forest, fig trees occurred at higher density (8.1 ± 3.7 trees/ha), in comparison with semi-deciduous forest, where it was only 1.4 ± 0.8 trees/ha.

Toco Toucan food resources use. In both forest types, I observed no Toco Toucan feeding on arthropods. However, I observed Toco

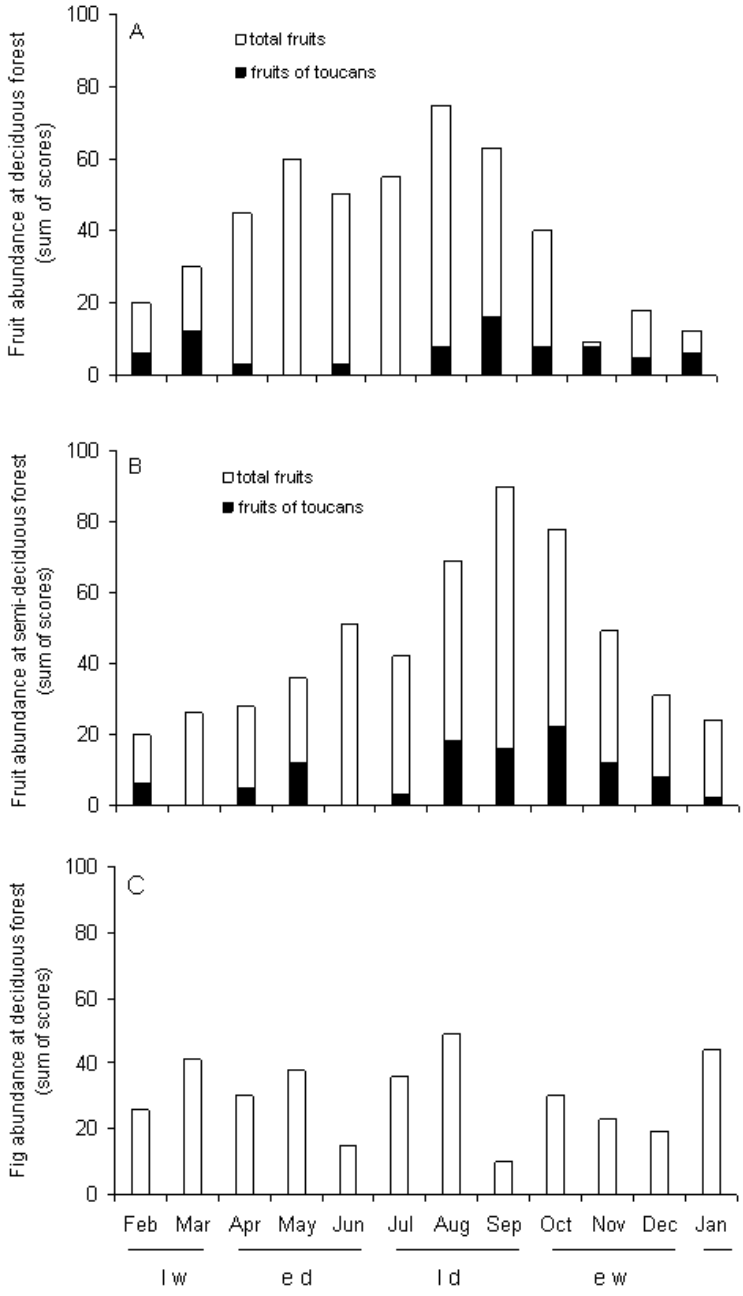

FIG. 1. Fruiting patterns in the deciduous and semi-deciduous forest (A, B), and fig production in the deciduous forest (C). In all cases values result from the sum of scores (see methods). (A) and (B): in black the sum of scores of fruits eaten by Toco Toucans (*Ramphastos toco*). (l w: late wet, e d: early dry, l d: late dry, and e w: early wet season; Corumbá, State of Mato Grosso do Sul, Brazil, 2001 and 2002).

TABLE 1. Plant species, consumed item , and habitat used by *Ramphastos toco* [n = 157 feeding toucans, 99 in the deciduous forest (DF), and 58 in the semi-deciduous forest (SDF)], as well as the percentage of toucans recorded ingesting every food item at each habitat type.

Plant taxa	Item	Month	Habitat	No. of feeding toucans (%)
Araliaceae				
Schefflera morototoni	pulp	Aug, Sept	SDF	28 (48.3)
Burseraceae				
Commiphora leptophloeos	aril	Dec	DF	2 (2.0)
Protium heptaphyllum	aril	Nov	SDF	1 (1.7)
Cecropiaceae				
Cecropia pachystachya	pulp	Feb	SDF	2 (3.4)
Lauraceae				
Nectandra cissiflora	pulp	Oct	SDF	2 (3.4)
Leguminosae				
Guibourtia hymenaefolia	aril	Apr, May	SDF	16 (27.6)
Meliaceae				
Guarea guidonia	aril	Nov	SDF	1 (1.7)
Moraceae				
Ficus calyptroceras	pulp	All year	DF, SDF	89 (89.9), 4 (6.9)
Sapindaceae				
Dilodendron bippinnatum	aril	Oct	SDF	4 (6.9)
Sterculiaceae				
Sterculia striata	aril	Sept, Oct	DF	8 (8.1)

Toucans consuming the fruits of ten tree species from nine families. Then, a total of 158 individuals fed on the available fruits. They foraged on three species in the deciduous and the rest in the semi-deciduous forest (Table 1). In the deciduous forest, despite of the consumption of only few fruit types a total of 99 toucans ate the available fruits (Table 1). In September and October, eight toucans fed on *Sterculia striatta* arillated seeds, while in December only two toucans consumed *Commiphora leptophloeos* arils. However, in this forest type most toucans (n = 89) foraged on figs (*Ficus calyptroceras*). Among the eight fruit species consumed in the semi-deciduous forest, toucans moderately foraged on four of them (Table 1). On the other hand, they extensively feed on *Guibourtia hymenaefolia* and *Schefflera morototoni* (n = 44 feeding toucans, Table 1). These species bore mature fruits from April to June and from July to September, respectively. During these six months no other species bore fruits available to Toco Toucans.

In the deciduous forest, Toco Toucans ate figs every month. Despite of the monthly fluctuations of their feeding activity (Fig. 2A), there was no seasonal significant variation in their feeding activity in the deciduous forest ($\chi^2 = 1.00$, df = 3, $P = 0.8$). This also occurred with the temporal proportion of figs available (see above). Conversely, in the semi-deciduous forest the monthly feeding activity of toucans fluctuated abruptly (Fig. 2B). In most months, few or even no toucans foraged in this area while in some periods several toucans exploited the seasonal available fruits (Fig. 2B). Therefore, the intra-seasonal proportion of toucans recorded feeding was significantly different ($\chi^2 = 20.6$, df = 3, $P = 0.001$). The peaks of feeding activity of toucans occurred both in the middle and late dry

season, coinciding with the availability of their major food (*Guibourtia hymenaefolia* and *Schefflera morototoni*) in the semi-deciduous forest (Table 1, Fig. 1B).

DISCUSSION

The seasonal forests evaluated in this study exhibited pronounced fruiting peaks, which widely overlapped the driest period of the year as well as the early rains. This pattern of fruit production is well known for Neotropical dry forests, in which massive fruiting usually occurs between the late dry and the early wet season (Frankie *et al.* 1974, Bullock & Solis-Magallanes 1990, Funch *et al.* 2002). However, for Toco Toucans fruit availability was very distinct between both areas. In the semi-deciduous forest, in fact, the fruits important for Toco Toucan were seasonally available, likewise at other feeding areas (Ragusa-Netto 2006, 2008b). In this forest much of Toco Toucan feeding activity included only two lipid-rich fruit species (*Guibourtia hymenaefolia* and *Schefflera morototoni*; Stiles 1993), which bore fruits during at least two months. Therefore, either before or after the availability of these fruits Toco Toucans were scarce or absent from the semi-deciduous forest. In the Brazilian cerrado Toco Toucan also mostly foraged on two lipid-rich fruits (*S. macrocarpa* and *Virola sebifera*), which diaspores exhibited similar traits. The extensive use of these fruit types, apparently, is a general trend in the diet of toucans because it is also common to toucans from rain forests (Galetti *et al.* 2000).

In the deciduous forest, although in some months an enhanced number of trees bore figs simultaneously, fig trees, fruited erratically resulting in a year-round fig availability (Lambert & Marshall 1991, Peres 2000). Toucans foraged all year in this forest where, proportionally, they exploited much of their food resources. Both the often and substantial consumption of figs suggest these fruits as suitable food resource at marked seasonal areas. In fact, unlike some frugivorous birds, which seldom forage on figs (Walker 2007), the generalist Toco Toucan (Ragusa-Netto 2008b), extensively exploit this resource regardless of season. Also, Toco Toucans regularly ate figs at a gallery forest in the South Pantanal where few large trees attracted several toucans at every fruiting episode (Ragusa-Netto 2006). However, apparently figs may be irrelevant for toucans of less seasonal areas. The Channel-billed (*Ramphastos vitellinus*) and Red-breasted (*R. dicolorus*) toucans made no use of figs, despite of its availability in the wet Atlantic forest (Galetti *et al.* 2000). Then, at a given area the importance of figs might results from factors, such as the fruiting seasonality and composition of tree species community, in which figs are likely to exhibit low-redundancy within a context of fruit production (Peres 2000). Indeed, in the deciduous forest, where fruiting pattern was dominated by dry fruits, other fleshy fruits comprised a minor proportion of items consumed by Toco Toucans. Hence, figs were likely the major cause for the use of this habitat type by Toco Toucans. The exploitation of a given habitat type caused by particular food resources is expected for mobile canopy frugivores, which track fruit availability either within or among habitats (Kinnaird *et al.* 1996, Renton 2001). Circumstantial evidences suggest that Toco Toucans may at least exhibit movements of dozens of kilometers searching for fruit patches (Short & Horne 2002, Ragusa-Netto 2008b). Despite of the distance between the study sites (30 km), both are yet connected and individuals might move from one to another forest to exploit adequate fruit crops. Apparently, likewise some hornbill species Toco Toucans foraged in both forest types in order to meet their nutritional requirements by combining high-quality (lipid-rich) fruits with figs (Walker 2007).

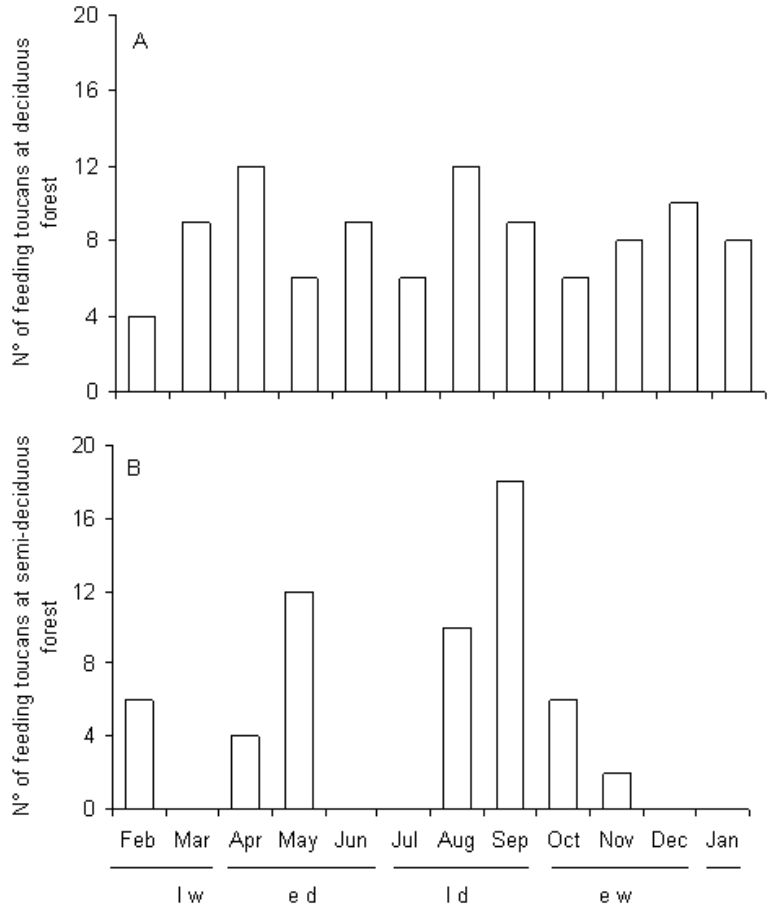

FIG. 2. Number of Toco Toucans (*Ramphastos toco*) monthly recorded eating the available food items in the deciduous forest (A) and semi-deciduous forest (B). (Abbreviations as in Fig. 1; Corumbá, State of Mato Grosso do Sul, Brazil, 2001 and 2002).

Figs exhibit important traits which have been pointed out them as keystone resources for frugivores (Lambert & Marshall 1991, Peres 2000). Particularly, while at population level fruiting is asynchronous the intra-crown ripening is highly synchronous. Then, a consumer may ingests several figs at every visit, which principally reduces foraging costs (Graham 2001). Also, the enhancement of analyses on the chemical content of several fig species has determined their nutritional quality and respective adequacy to the diet of frugivores (Wendeln *et al.* 2000). In fact, some frugivorous birds may virtually rely exclusively on figs (Lambert & Marshal 1991, Kinnaird *et al.* 1996), or at least use extensively the large fruit crops available during the lean season (for a review see Peres 2000).

The present study, as well as two previous ones (Ragusa-Netto 2006, 2008b), stress out the diverse Toco Toucan feeding habits in response to the spatial and temporal dynamics of fruiting patches. This flexibility is often a trait of generalist frugivorous birds, which diet

mirrors the temporal and spatial patterns of fruit availability (Sun & Moermond 1997, Renton 2001, Ragusa-Netto 2008b). Due to the spatial and temporal rarity and variability of fruit resources (Goerck 1997, Bonadie & Bacon 2000), frugivores inhabiting Neotropical areas are particularly vulnerable to continued habitat loss and fragmentation (Christiansen & Pitter 1997, Goerck 1997). In western Brazil, the dry forests are yet common, although under an accelerated deforestation process, similarly to the dry forests present elsewhere in South America (Murphy & Lugo, 1986). These forests remain almost unstudied, except for neighboring areas in Bolivia (Justiniano & Fredericksen, 2000). The deciduous forest and semi-deciduous forest are marked seasonal components of a habitat mosaic in Corumbá. These forests include fruit species, potentially very distinct with respect to both nutritional quality and the temporal patterns of availability to Toco Toucan. The exploitation of diverse habitat types caused by their peculiar food resources emphasizes the importance of habitat mosaics for large canopy frugivores, such as Toco Toucan, which conservation undoubtedly depends on the maintenance and connectivity of fruit patches (Graham 2001). Data presented here contribute to our knowledge on the generalistic habits of Toco Toucan, explaining the persistence and wide distribution of this species in the dry interior of Brazil.

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